Appendix 6. The Gateway Light Rail Corridor Serving Portland, Oregon

Executive Summary

Working Paper 1 (Subtask 1d, November 25, 1998) develops a theoretical and measurement framework within which the Mogridge-Lewis Convergence Hypothesis (MLC) can be employed in measuring the savings in highway delay attributable to transit and its equilibrating effect on the level of service in the corridor.

The framework also provides an MLC-based approach to making repeated measures of transit-induced savings in corridor delay without the need for repeated MLC surveys. The approach rests on the theoretical proposition, proven in Working Paper 1, that a stable and measurable relationship exists between roadway traffic growth over time and the inter-modal (highway-transit) equilibrium dynamics that give rise to delay savings in a congested corridor. In the absence of major changes in the level of highway supply or transit service in the corridor, this measured relationship, or model, provides a formula-based performance measurement system in lieu of a survey-based approach. In addition to the obvious cost advantages, this approach provides FTA with (i) an efficient means of measuring and comparing transit performance in strategic corridors; and (ii) a consistent performance assessment tool for transfer to MPOs throughout the country.

Purpose and Method

This Working Paper presents a case study of the methodology developed in Subtask 1c in application to the Gateway-Portland corridor (the MAX light rail system). The methodology consists of calibrating the MLC-traffic model with Gateway-Portland survey data. The model is then used to quantify delay savings attributable to MAX at present, and at alternative roadway traffic volumes (each for different user categories).

The study consists of four main steps:

1. Collecting highway travel data (traffic volume, distance, travel time, and vehicle occupancy in the corridor); and light rail ridership data along the corridor;
2. Conducting door-to-door travel time surveys and deriving the inter-modal convergence;
3. Estimating the “with transit” and “without transit” model and related curves and estimating the hours of delay saved due to transit; and
4. Quantifying delay savings by user category, namely, (i) light rail riders (“market” benefits); (ii) common segment users (“club” benefits); and, (iii) parallel highway users (“spillover” benefits).

The Gateway-Portland corridor was selected to measure the performance of the MAX light rail system connecting several residential areas with the Central Business District of Portland, Oregon. MLC theory predicts that the improved transit system will attract modal explorers, reduce congestion, and improve roadway travel times. As a result, we would expect to see improvements in both highway and transit door-to-door travel times

Principal Findings

The case study finds that based on the MLC model calibrated with 1999 survey data, the magnitude of peak-period delay savings per trip due to transit is about 3.05 minutes per door-to-door journey. These

savings amount to about 11 percent of total door-to-door journey times and align with reasoned expectations.

HLB estimated the hours of delay savings for three different user groups: Metro riders (market benefits), users of the I-84 common segment (club benefits), and users of parallel highways (spillover benefits). Table A 6.1 through Table A 6.4 present the estimated delay savings by category of user. Based on an assumed value of peak travel time of $15 per hour and an average of 250 working days per year, Table A 6.4 indicates an aggregate peak delay savings due to transit of $20.8 million for 1999.

Table A 6.1 Daily Club Benefits for Gateway-Portland Corridor

	Distance (miles)	Daily Volume	Savings (hours)
Common Segment			
I-84	6.11	53,425	1,161.36
I-5	1.07	44,738	170.31
Morrison Bridge	0.25	20,763	18.47
Access Segment			
(on average)	2	20,763	147.74
Total	9.43		1,497.88

Table A 6.2 Daily Market Benefits for Gateway Portland Corridor

Station	In-bound Trips	Out-bound Trips	Savings (hours)
Gateway TC	1,833	2,032	108.08
NE 82nd Avenue]	1,533	1,889	90.89
NE 60th Avenue	1,617	2,048	92.22
Hollywood/NE 42nd TC	1,542	2,173	88.27
Lloyd Center/NE 11th Ave.	1,867	2,063	87.89
NE 7th Avenue	2,983	1,774	99.76
Convention Center	3,167	1,669	94.64
Rose Quarter TC	1,542	2,173	67.50
Old Town/Chinatown	1,867	2,063	65.92
Skidmore Fountain	2,983	1,774	73.16
Oak Street/SW 1st Ave.	3,167	1,669	60.84
SW 3rd Avenue/Yamhill	2,533	1,568	45.86
Mall/SW 5th-/SW 4 th Ave.	2,717	1,347	39.76
Pionner Square N/S	2,567	1,348	32.84
Total			1,048

Table A 6.3 Daily Spillover Benefits for Gateway-Portland Corridor

Highways in the Corridor	Distance (miles)	Daily Traffic Volume	Savings (hours)
NE Halsey Street	7.5	11,525	276.77
NE Glisan Street	11	15,450	544.18
SE Stark Street	9	7,650	195.96
E Burnside Street	11	16,050	533.91
NE Sandy Boulevard	12.5	18,475	575.14
Broadway Avenue	6	21,738	324.82
Weidler Street	3.25	31,425	254.35
Multnumah Street	3	13,425	100.30
Holladay Boulevard	2	1,046	5.21
Yamhill Street	11.5	6,425	184.01
Total			2,995

Table A 6.4 Network Benefits Summary

	Daily Savings		Yearly Savings
Benefit Category	In Hours	In Dollars	In Dollars
Market	1,048	$ 15,714	$ 3,928,622
Club	1,498	$ 22,468	$ 5,617,034
Spillover	2,995	$ 44,920	$ 11,229,998
Total	5,540	$ 83,103	$ 20,775,654

Table A 6.4 shows that the 1998 delay saving attributed to transit on the Gateway-Portland corridor is estimated at about $20.8 million. This can be translated to $2.2 million per rail mile.

The methodology implies that in the absence of major infrastructure improvements or strong growth in volume of traffic the performance metric will remain stable. So, it should suffice to gather corridor travel time—degree of convergence—once every several years. In the case of major infrastructure improvement or a change in the transit service, however, door to door travel time data should be collected to estimate an accurate performance metric.

Figure A 6.1 displays the "with-" and "without transit" curves using 1999 convergence data. The vertical difference between the "with-" and "without transit" curves represents the delay savings due to transit at different volumes of the common segment traffic. The curves indicate that in the absence of major infrastructure improvements or radical traffic growth, the performance metric will remain stable.

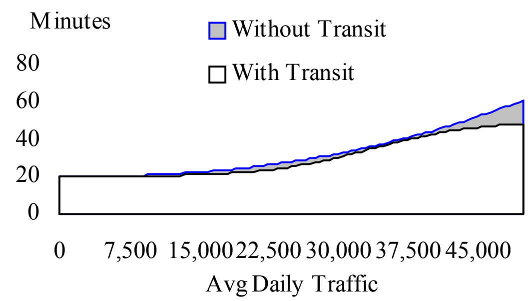

Figure A 6.1 "With-" and "Without Transit" Curves

Although an intermodal travel time convergence of 13 minutes is sufficient to yield delay savings to highway users (as compared to the "without rail" case), full convergence would of course yield even greater savings. Why is the convergence level as high as 13 minutes? Stated differently, why is it that, even though door-to-door average peak-period roadway travel time is 13 minutes less than the average door-to-door travel time by light rail, light rail users are not re-exploring the roadway option by enough to "bid-up" roadway times any further?

The Mogridge-Lewis framework predicts that non-time related roadway travel costs (ie, the non-time elements of "generalized cost" such as parking costs, fuel costs and so on) account for the "13 minute wedge." Light rail users are expected to re-explore the roadway option to the point at which the value of non-time generalized cost factors just equals the value of the travel time advantage offered by road. If non-time costs are moderate to high, travel time convergence will occur at a non-zero time differential between road and rail. Such is the case at-hand. In particular, parking costs in downtown Portland are well above the national average. Parking capacity is low as a matter of land-use and transportation planning policy, which means that the time-related costs of finding parking and gaining walk-access to the final destination thereafter are higher than the national average. Also, low parking capacity drives the money cost of parking above the national average. The Mogridge-Lewis framework predicts convergence at a non-zero travel time differential in such circumstances. It also predicts convergence at a travel time differential that lies above the national average differential for corridors in convergence. Both predictions are borne out in the Portland case presented here.

The design of expanded park-and-ride facilities in response to capacity constraints at existing stations will materially influence the extent and direction of inter-modal exploration. Designs that minimize auto-to-platform walking times (such as vertical structures rather than ground-level expansion) encourages auto users to explore light rail and discourages light rail users from exploring auto. This in-turn helps maximize light-rail's convergence-related benefits. Portland's current parking structure in stations such as Gateway Station ("horizontal" rather than "vertical" park-and-ride expansion) is not consistent with the maximization of transit's performance as a "regulator" of multi-modal corridor performance.

Figure A 6.2 MAX light Rail running through transit-dedicated streets in Downtown Portland

Figure A 6.3 MAX Light rail servicing a residential area in north Portland

Introduction

This report presents the results for the Gateway-Portland corridor case study as part of Streamlined Strategic Corridor Travel Time Management study. The purpose of the study is to use the convergence measurement technique to derive a repeatable performance measurement for rail transit in congested corridors. This case study measures the performance of Portland's light rail system—known as MAX—using the methodology developed in Subtask 1c. The methodology consists of calibrating the Mogridge-Lewis Convergence Hypothesis (MLC) model with survey data and using the model to quantify delay savings attributable to transit at different roadway traffic volumes. The savings are estimated for three different user categories using highway traffic data and light rail ridership in the corridor.

Study Methodology

The study methodology consists of four main steps:

1. Collecting highway travel data (traffic volume, distance, travel time, and vehicle occupancy in the corridor); and light rail ridership data along the corridor;
2. Conducting door-to-door travel time surveys and deriving the inter-modal convergence;
3. Estimating the "with transit" and "without transit" model and related curves and estimating the hours of delay saved due to transit; and
4. Quantifying delay savings by user category, namely, (i) light rail riders ("market" benefits); (ii) common segment users ("club" benefits); and, (iii) parallel highway users ("spillover" benefits).

During the first step, HLB collected HPMS data, local arterials traffic data, and light rail ridership data from METRO (the local MPO) and Tri-Met (the Tri-County Metropolitan Transportation District of Oregon). The data were used to estimate the model parameters.

For the second step, data was collected on site—Gateway-Portland corridor—by a survey team. A corridor, as defined in this study, is a principal transportation artery into the central business district. Multiple transportation services are available to commuters who use this artery. Additionally, during the peak period a large number of commuters utilize this route in their door-to-door commute.

A statistical sample of trips was generated in the corridor by identifying random trip end point in the zones at either end of the corridor and joining them so that trips alternated between zones. These zones are catchment zones where travelers converge or diverge from either the transit station or the principal highway route. In this study these zones are defined as the access segment and the component of the corridor common to all trips for a given mode, regardless of trip end location, is defined as the common segment.

Survey crews were instructed to follow specific routes that consisted of an access segment—dependent on the catchment zone considered for the trip—and a common segment. The data collected include start times and arrival times for each segment, by mode, congestion level, seating availability, weather, road conditions, and travel costs for each segment.

Data were collected over a period of three consecutive days (Tuesday to Thursday) during the first week of February 1999. The days of the week were sampled to eliminate fluctuations in traffic patterns and volumes due to the day of week effects. Trips were validated to minimize the effects of unusual or circumstantial conditions. Sixty valid trips were selected to ensure a statistically adequate sample size. The study employed the maps and routes connecting several zones within a residential area to several points within Portland's central business district.

Step three consisted of estimating the "with transit" curve based on the traffic volume and the door to door travel time. Using the model developed in Subtask 1c, HLB derived the "without transit" curve and estimated the hours of delay saved due to transit. This performance metric is defined as the vertical difference between the two curves.

In step four, the hours of delay saved due to transit are aggregated into three user categories. Savings by common highway-segment users are estimated using the traffic volume on the segment. Savings by light rail riders are estimated using the ridership data for each station along the corridor. Savings by parallel highways users are estimated using traffic volume on parallel highways and arterials within the corridor. The magnitude of the savings decreases as the distance between the common segment and the arterial increases.

Plan of the Report

This report presents the results from the Gateway-Portland corridor case study. Following this introduction, Chapter 2 presents an overview of the model and methodology to estimate the delay saving. Chapter 3 displays the corridor characteristics and a description of the principal modes of transportation within the corridor. Chapter 4 presents the results from the 1999 door-to-door travel survey and shows the model estimation results. The chapter estimates the hours of delay saved due to transit per person per day, and provides a monetary value of the delay saved for three user categories. Appendices provide maps of the residential area and the central business district as well as supporting data and supplementary results on the survey findings by route.

Methodology and Model Overview

The methodology consists of four steps:

1. Estimating the Corridor Performance Baseline
2. Estimating the Corridor Performance in the Absence of transit
3. Extrapolating Delay Savings Due to Transit
4. Estimation of Corridor Performance without Re-calibration

Estimating the Corridor Performance Baseline

The Model This model establishes a functional relationship between the person trip volume –all modes—and the average door to door travel time by auto in the corridor.

The door to door travel time by auto can be determined using a logistic function which calculates the door to door travel time in terms of travel time at free flow speed, trip time by high capacity rail mode, and the volume of trips in the corridor for all modes. The door to door travel time can be estimated as follows:

$$\mathbf{T = (T_c - T_{ff}) / (1 + e^{-(\delta + \varepsilon V1)}) + T_{ff}} \qquad \mathbf{(1)}$$

Where T_{a1} is auto trip time,

Tc is trip time by high-capacity rail mode

T_{ff} is auto trip time at free-flow speed,

V is person trip volume in the corridor by auto, and

δ, ε are model parameters

Equation 1 implies that the door to door auto trip time is equal to the trip time at free-flow speed plus a delay which depends on transit travel time and the person trip volume in the corridor.

In other words, when the highway volume is close to zero, travel time is equal to travel time at free flow speed.($T = T_{ff}$). As the volume increases, the travel time is equal to T_{ff} plus a delay due to the high volume, but adjusted to the travel time by high capacity transit. That is the high capacity transit alleviates some of the highway trip delay as some trips shift to transit.

Equation 1 is transformed into a linear functional form before the parameters δ and ε can be estimated, the transformed equation will be:

$$\mathbf{U = \delta + \varepsilon V_1} \qquad \mathbf{(2)}$$

Where $U = \ln [(T_c - T_{ff}) / (T - T_{ff}) - 1]$

Equation 2 is estimated using Ordinary Least Squares regression.

Data The data required for the estimation of the above equations are:

person trip volume on the highway which can be calculated by dividing the traffic volume by the average vehicle occupancy (auto and buses). This data are available through HPMS data base and MPO's traffic data.

free flow trip time is a constant.

high capacity trip time is a constant.

The parameters δ and ε do not have to be re-estimated each year, they are both specific to the corridor and are relatively stable over the years. So periodically, the person trips volume can be inserted into Equation 1 to estimate the door to door travel time by auto.

Estimating the Corridor Performance in the Absence of transit

The Model This model represents the concept to quantify the role of transit in congestion management. In the absence of transit, the travel time Ta is estimated as:

$$\mathbf{T_a = T_{ff} * (1 + A (V^*)^{\beta})} \qquad \mathbf{(3)}$$

Where T_a is the door to door travel time in the absence of transit,

T_{ff} is the trip travel time at free-flow speed,

V^* is the volume of person trips by auto in the absence of transit,

A is a scalar, and β is a parameter.

Equation 3 implies that the door to door travel time in the absence of transit depends on the travel time at free-flow speed and the level of congestion on the road in the absence of transit.

The volume of person trips by auto in the absence of transit, however, depends on several factors:

The existing auto and bus person trips on the highway.

The percentage of person transit trips shifting to auto

The percentage of person transit trips shifting to bus

The number of additional cars in the highway

The number of additional buses in the highway

The occupancy per vehicle in the absence of transit

The volume of person trips by auto, in the absence of transit, can then be estimated as:

$$\mathbf{V^* = V_1 + \alpha_1 V_c + \alpha_2 V_b} \qquad \mathbf{(4)}$$

Where : V_1 is the existing auto volume,

V_c is the transit person trips diverted to cars,

V_b is the transit person trips diverted to buses, and

α_1, α_2 are the coefficients that incorporate the passenger car equivalent factor, and the occupancy per vehicle (cars and buses).

The trips diverted to cars and buses depend mainly on the degree of convergence in the corridor. This degree of convergence reflects the transit user behavior and the composition of these users. The transit users can be divided into 3 categories:

1. Type 1: “Explorers” who are casual switchers and who will divert to Single Occupancy Vehicles in the absence of transit.
2. Type 2: Commuters with low elasticity of demand with respect to generalized cost and who will divert to use the bus or carpool.
3. Type 3: Commuters with high elasticity of demand with respect to generalized cost and who will forgoes the trip.

The higher the degree of convergence (auto and rail door to door travel times are very close), the higher the shift of transit riders to cars and buses. Therefore, higher degree of convergence will lead to higher delay, which translates into higher savings due to transit.

In words, Equation 3 shows that in the absence of transit and in the case of a high degree of convergence, the person trip volume is very high which translates into a high trip time (excessive delay). The relationship between trip time and person trip volume can be expressed as a convex curve (as the volume increases, travel time increases at an increasing rate). Figure A 6.4 illustrates the relationship between the volume and travel time both in the presence and in the absence of transit.

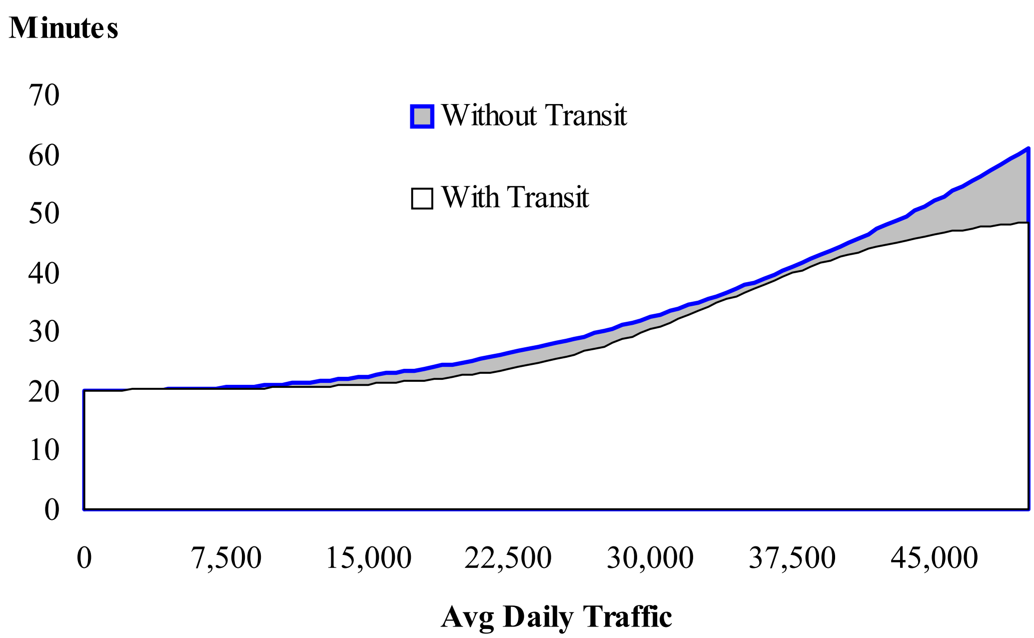

Figure A 6.4 Travel time both in the presence and in the absence of transit

<u>Data</u> The data required to populate this model consist of:

Highway person trip volume (used in the previous model)

Transit ridership data

Fleet composition (cars and buses percentages out of the total traffic)

Cars and buses vehicle occupancy

Passenger car equivalent factor

Degree of convergence to determine the percentage person trips shifting to cars and buses

Free-flow travel time which is a constant

Equation 3 is specific to the corridor and do not need to be estimated each year. It will only be necessary to re-estimate them with an updated degree of convergence if a major change is made to the transit level of service or the highway structure.

Extrapolating Delay Savings Due to Transit

While the MLC hypothesis proves to be valid during the peak period only, the delay savings due to transit can be estimated during off-peak as well. This metric can be estimated as the vertical difference between the "without transit" curve and the "with transit" curve. That is at a specific person trip volume, the difference in travel times between the two cases can be defined as "the hours of delay saved due to transit".

The estimated hours of delay savings due to transit are an aggregation of three different user savings: savings by Metro riders (market benefits), savings by highway users (club benefits), and savings by users of parallel highways (spillover benefits).

The market benefits are estimated based on delay saved (which depends on the distance traveled) for each rider within the common segment.

The club benefits are estimated based on the volume on the common segment using origin-destination table and the daily trip distribution.

The spillover benefits are estimated based on the savings per mile, traffic volume, and the distance traveled on segments parallel to the common segment. The spillover benefits are calculated by multiplying the traffic volume with a percentage of the delay savings. This percentage decreases as the distance between the common segment and the parallel highway increases.

Estimation of Corridor Performance without Re-calibration

The framework, presented above, provides an MLC-based approach to making repeated measures of transit-induced savings in corridor delay without the need for repeated MLC surveys. The approach rests on the theoretical proposition, that a stable and measurable relationship exists between roadway traffic growth over time and the inter-modal (highway-transit) equilibrium dynamics that give rise to delay savings in a congested corridor. In the absence of major changes in the level of highway supply or transit service in the corridor, this measured relationship, or model, provides a formula-based performance measurement system in lieu of a survey-based approach. In addition to the obvious cost advantages, this approach provides FTA with (i) an efficient means of measuring and comparing transit performance in strategic corridors; and (ii) a consistent performance assessment tool for transfer to MPOs throughout the country.

Corridor Overview

The Gateway-Portland corridor is about 8 miles in length and connects the residential area east of I-205 and I-84 Bypass with the CBD in Portland, Oregon. The residential catchment zone is centered around the Gateway/NE 99th Avenue Transit Center. Trip end points within the residential zone are no more than a 15 minutes drive or bus ride to the station. The downtown Portland, Oregon zone, centered around the Pioneer Square Light Rail Station, extends for a radius of .6 miles. App. Annex A1 provides maps of the residential and business district zones considered in this study. The Gateway-Portland MAX light rail line is part of the 15-mile line connecting Downtown Portland with the City of Gresham, East of Portland. This line was opened on September 5th, 1986.

Principal Travel Modes

The "principal travel mode" is defined as the mode used during the common segment of each individual trip. The main transportation modes serving the Gateway-Portland Corridor are automobile and the light rail, MAX. The Gateway-Portland MAX line is a 6.16-mile segment of the 15-mile Eastside MAX line serving the area between downtown Portland and the city of Gresham.

Automobile routes can be broken into three distinct sections:

1. The route between the residential point and the intersection of I-84 and NE Halsey in Gateway TC area (Access1);
2. The route from the intersection of I-84 and NE Halsey in Gateway TC area to the intersection of SW Washington Street and Second Avenue (Common Segment); and
3. The route from the intersection of SW Washington Street and Second Avenue and the CBD point (Access2).

For a morning rush hour trip, survey drivers followed Access1 to the common segment. The common segment route originated at the intersection of I-84 and NE Halsey in Gateway TC area. Drivers followed I-84 West to I-5 South to northwest on Morrison Bridge, up to SW Washington and Second Avenue. From the end of the common segment, survey drivers followed Access2 to the downtown points, at which time they parked at the closest parking lot and proceeded on foot to the end point. The evening rush hour trip covered the same progression in the opposite direction.

The routes for the MAX light rail mode can also be broken into three distinct sections:

1. The route between the residential point and the Gateway Transit Center (Access1);
2. The route between the Gateway Transit Center and the Pioneer Square North light rail station (Common Segment); and
3. The route between the Pioneer Square North light rail station and the CBD point (Access2).

For a morning rush hour trip, survey crews rode the bus or drove Access1 to the Gateway Transit Center Metro Station parking lot and walked from the lot (or the bus stop) to the MAX station. The route taken for the common segment consisted of a light rail trip which began at the Gateway TC and continued to the Pioneer Square North MAX Station. From the end of the common segment, the surveyor walked Access2 to the downtown points. The evening rush hour trip covered the same progression in the opposite direction. On average, trains run every 6 minutes during peak hours. Table A 6.5 displays some of the principal performance and service characteristics of the corridor.

Table A 6.5 Performance and Service Characteristics for Gateway-Portland Corridor

	Automobile	Light Rail
Number of stops	N/A	13
Number of Streets and Highways	3	N/A
Tolls/Fares for a one way (in dollars)	$0.00	$1.40

One of the main characteristics The Gateway-Portland corridor is that the MAX light rail line and the I-84 common segment are side-by- side for about 5.5 miles from Gateway TC/99th Avenue to the Lloyd Center/ NE 11th Avenue. Figure A 6.5 shows the Gateway-Portland corridor and the main highways and arterials in the area.

Another feature of the MAX line is that it runs through a sport complex—Rose Garden Arena—and nearby High-Schools around Hollywood TC and 42nd Avenue. This line configuration made MAX a good transportation choice not only for daily commuters but for sport fans and students as well.

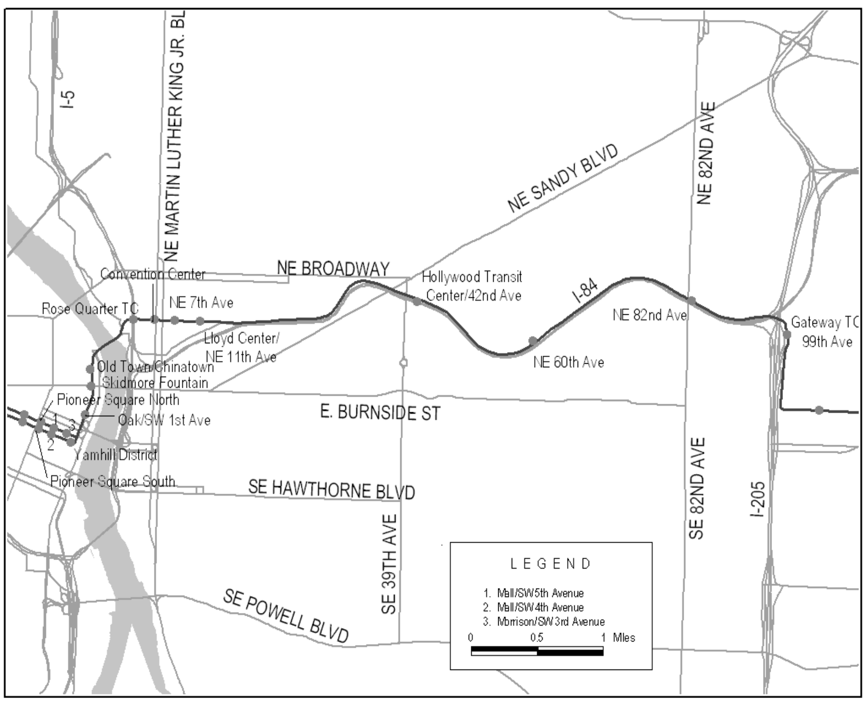

Figure A 6.5 Map of the Gateway-Portland Corridor

Figure A 6.6 Transit Station (Park and Ride facility) for Bus and Light Rail located south of Portland

Figure A 6.7 Max Light rail sharing the streets of Downtown Portland

Principal findings

This chapter starts by presenting the results from the door-to-door travel survey conducted during the first week of February 1999. The travel survey data are used to derive the inter-modal convergence level in the Gateway-Portland corridor. The chapter then presents the estimation of the hours of delay saved due to transit for different user categories.

The Convergence Level

The starting point to estimate the "without transit" curve is to determine the convergence level based on the key findings from the 1999 door to door travel data. The door to door travel survey for the Gateway-Portland Corridor found that:

- Average door-to-door travel times for auto and metro rail, are not similar, 38.3 minutes by light rail versus 27.3 minutes by auto (Table A 6.6).
- Travel time reliability, as represented by the standard deviation of average travel time, is similar, 5.6 for light rail mode compared and 4.2 for the auto mode (Table A 6.6).
- Commuters experienced similar travel times in the morning and in the evening reflecting the similar traffic dynamics of the inbound peak flow versus the outbound peak flow in the corridor (Table A 6.7).
- Statistical analysis shows that the mean trip time by auto was at most 13 minutes longer with 95% confidence (Table A 6.8).
- The common segment travel time was greater for the light rail mode than for the transit mode, 23.3 minutes versus 15.9 minutes. The difference of 7.4 minutes between the two modes is due to lower congestion on the highways as more commuters use the light rail[1]. (Table A 6.6).
- Access segment travel times indicate that auto commuters spent 4 minutes on average less outside the common segment than transit commuters. The difference is mainly due to the waiting time for the light rail (Table A 6.6).
- Access segment travel time for commuters who rode the bus to and from the light rail station was 3.5 minutes higher than for commuters who drove to and from the station. This is mainly due to the wait for at the bus stop.

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1 In 1997, 72% of Tri-Met customers have a car, but prefer to ride Tri-Met, and during Fiscal Year 1997 MAX experienced an 8.8% increase in Ridership.
Source: Tri-Met Attitude & Awareness Survey, August 1997.

Table A 6.6 Results for the Gateway-Portland Corridor

	Automobile	Light Rail -MAX
Total Travel Time		
Mean	27.3	38.3
Standard Deviation	4.2	5.6
Access Segment Travel Time		
Mean	11.4	15.0
Standard Deviation	2.1	4.2
Common Segment Travel Time		
Mean	15.9	23.3
Standard Deviation	4.5	2.9
Sample Size	30	30

Table A 6.7 Comparison of AM and PM Trip Times by Modes

	Auto	Metro Rail
Inbound AM Average Trip Time	27	37.8
Outbound PM Average Trip Time	26.3	37.6

Table A 6.8 Statistical Testing of Convergence Hypothesis

Difference in Mean Travel Times by Mode (Auto- Metro Rail minutes)		11.1
Standard Error of the Difference of the Means (minutes)		1.28
Hypothesis: “The difference between the mean travel times by modes is at most...”	Significant at the 0.10 Level (90% Confidence)	Significant at the 0.05 Level (95% Confidence)
10 Minutes	NO	NO
11 Minutes	NO	NO
12 Minutes	NO	NO
13 Minutes	YES	YES
14 Minutes	YES	YES

The results in Table A 6.8 indicate that light rail in the defined corridor has drawn door-to-door travel times by highway and light rail to within no more than 13 minutes of one another during congested roadway conditions (with 95 percent statistical confidence).

Although an inter-modal travel time convergence of 13 minutes is sufficient to yield delay savings to highway users (as compared to the "without rail" case – see below), full convergence would of course yield even greater savings. Why is the convergence level as high as 13 minutes? Stated differently, why is it that, even though door-to-door average peak-period roadway travel time is 13 minutes less than the average door-to-door travel time by light rail, light rail users are not re-exploring the roadway option by enough to "bid-up" roadway times any further?

The Mogridge-Lewis framework predicts that non-time related roadway travel costs (i.e, the non-time elements of "generalized cost" such as parking costs, fuel costs and so on) account for the "13 minute wedge." Light rail users are expected to re-explore the roadway option to the point at which the value of non-time generalized cost factors just equals the value of the travel time advantage offered by road. If non-time costs are moderate to high, travel time convergence will occur at a non-zero time differential between road and rail. Such is the case at-hand. In particular, parking costs in downtown Portland are well above the national average. Parking capacity is low as a matter of land-use and transportation planning policy, which means that the time-related costs of finding parking and gaining walk-access to the final destination thereafter are higher than the national average. As well, low parking capacity drives the money cost of parking above the national average. The Mogridge-Lewis framework predicts convergence at a non-zero travel time differential in such circumstances. It also predicts convergence at a travel time differential that lies above the national average differential for corridors in convergence. Both predictions are borne out in the Portland case presented here.

The design of expanded park-and-ride facilities in response to capacity constraints at existing stations will materially influence the extent and direction of inter-modal exploration. Designs that minimize auto-to-platform walking times (such as vertical structures rather than ground-level expansion) encourages auto users to explore light rail and discourages light rail users from exploring auto. This in-turn helps maximize light-rail's convergence-related benefits. Portland's current parking structure in stations such as Gateway Station ("horizontal" rather than "vertical" park-and-ride expansion) is not consistent with the maximization of transit's performance as a "regulator" of multi-modal corridor performance.

Methodology Application on Gateway-Portland Corridor

<u>Data</u> HLB collected HPMS data, local arterials traffic data, and light rail ridership data from METRO (the local MPO) and Tri-Met (the Tri-County Metropolitan Transportation District of Oregon). In addition door to door travel time survey was conducted to derive the corridor degree of convergence. HLB estimated the model, described in Section 1 using the obtained data.

<u>Model</u> Equation 1 is estimated as follows:

$$\mathbf{T_{a1} = (60 - 15) / (1 + e^{-(-9.14 + 0.000174\,(V))}) + 15} \tag{1}$$

Similarly, Equation 2 is estimated based on auto travel volume, transit ridership data, and convergence level estimate from the survey.

$$\mathbf{T_{a2} = 15 * (1 + 3.49E\text{-}18\,(V^*)^{3.7})} \tag{2}$$

The auto traffic volume in the absence of transit is determined by adding the auto volume in the presence of transit to the generated auto trips by transit riders. The generated results are based on:

- About 40% of person transit trips will be forgone (determined by the corridor convergence level).
- The average vehicle occupancy (HOV and non-HOV) is 1.2 for cars and 40 for buses.
- Car trips will make about 90% of trips.

Benefit Estimation

To estimate the travel time saving (TTS) attributed to transit, the current traffic volume is inserted into Equation 1 and 2. An auto volume of 37,500 results into:

$$T_{a1} = 25.10, \quad T_{a2} = 28.15, \text{ and . } TTS = T_{a2} - T_{a1} = 3.05$$

That is on average, in Gateway-Portland corridor, transit saves about 3.05 minutes per auto trip (6 seconds per mile) during the peak period. Once the average travel time saving per vehicle is estimated, the savings are weighted to reflect the congestion level at each time of the day.

The benefits are calculated for three user groups:

1. Benefits to highway users (Club), these are the hours saved by the common segment user of the Gateway-Portland corridor (see Table A 6.9).
2. Benefits to Transit users (Market), these are the hours saved by the users of transit between Gateway TC and Pioneer Square Station (see Table A 6.10).
3. Benefits to the highway network users within the corridor (spillover), these are the hours saved by users of parallel and adjacent highways to the common segment within the corridor (see Table A 6.11).

Table A 6.9 Club Benefits for Gateway-Portland Corridor

	Distance (miles)	Avg Daily Traffic Volume	Daily Savings (hours)
Common Segment			
I-84	6.11	53,425	1,161.36
I-5	1.07	44,738	170.31
Morrison Bridge	0.25	20,763	18.47
Access Segment (average)	2	20,763	147.74
Total	9.43		1,497.88

Table A 6.10 Market Benefits for Gateway-Portland Corridor

Station	In-bound Trips	Out-bound Trips	Daily Savings (hours)
Gateway TC	1,833	2,032	108.08
NE 82nd Avenue]	1,533	1,889	90.89
NE 60th Avenue	1,617	2,048	92.22
Hollywood/NE 42nd TC	1,542	2,173	88.27
Lloyd Center/NE 11th Ave.	1,867	2,063	87.89
NE 7th Avenue	2,983	1,774	99.76
Convention Center	3,167	1,669	94.64
Rose Quarter TC	1,542	2,173	67.50
Old Town/Chinatown	1,867	2,063	65.92
Skidmore Fountain	2,983	1,774	73.16
Oak Street/SW 1st Ave.	3,167	1,669	60.84
SW 3rd Avenue/Yamhill	2,533	1,568	45.86
Mall/SW 5th-/SW 4 th Ave.	2,717	1,347	39.76
Pionner Square N/S	2,567	1,348	32.84
Total			1,048

Table A 6.11 Spillover Benefits for Gateway-Portland Corridor

Highways in the corridor	Distance (miles)	Avg Daily Traffic Volume	Daily Savings (hours)
NE Halsey Street	7.5	11,525	276.77
NE Glisan Street	11	15,450	544.18
SE Stark Street	9	7,650	195.96
E Burnside Street	11	16,050	533.91
NE Sandy Boulevard	12.5	18,475	575.14
Broadway Avenue	6	21,738	324.82
Weidler Street	3.25	31,425	254.35
Multnumah Street	3	13,425	100.30
Holladay Boulevard	2	1,046	5.21
Yamhill Street	11.5	6,425	184.01
Total			2,995

Table A 6.12 Benefits Summary

	Daily Savings		Yearly Savings
Benefit Category	In Hours	In Dollars	In Dollars
Market	1,048	$ 15,714	$ 3,928,622
Club	1,498	$ 22,468	$ 5,617,034
Spillover	2,995	$ 44,920	$ 11,229,998
Total	5,540	$ 83,103	$ 20,775,654

Table A 6.12 shows that the 1998 delay saving attributed to transit on the Gateway-Portland corridor is estimated at about $20.8 million. This can be translated to $2.2 million per rail mile.

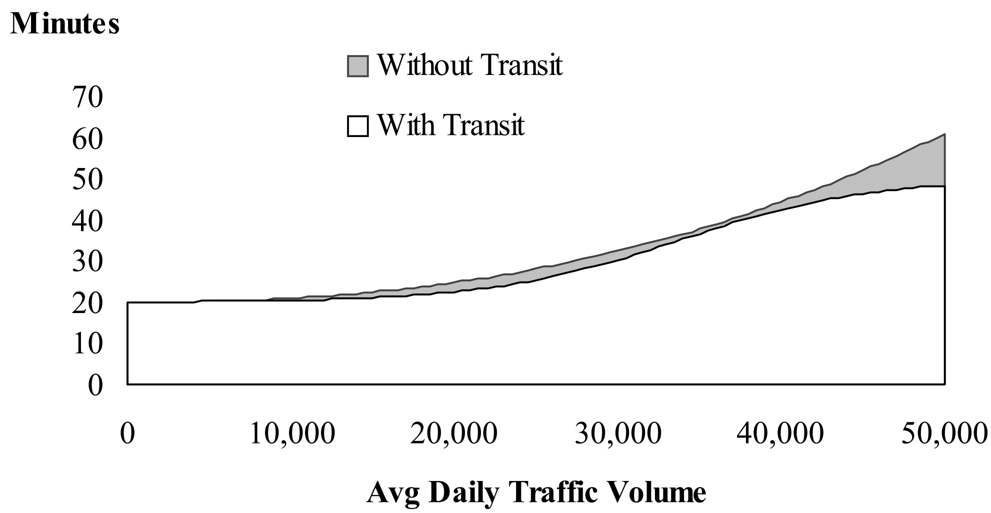


Figure A 6.8 Illustration of the "With-" and "Without Transit" Curves for Portland

The methodology implies that in the absence of major infrastructure improvements or strong growth in volume of traffic the performance metric will remain stable. So, it should suffice to gather corridor travel time—degree of convergence—once every several years. In the case of major infrastructure improvement or a change in the transit service, however, door to door travel time data should be collected to estimate an accurate performance metric.

Annex A 6.1 Views of The Gateway Light Rail Corridor

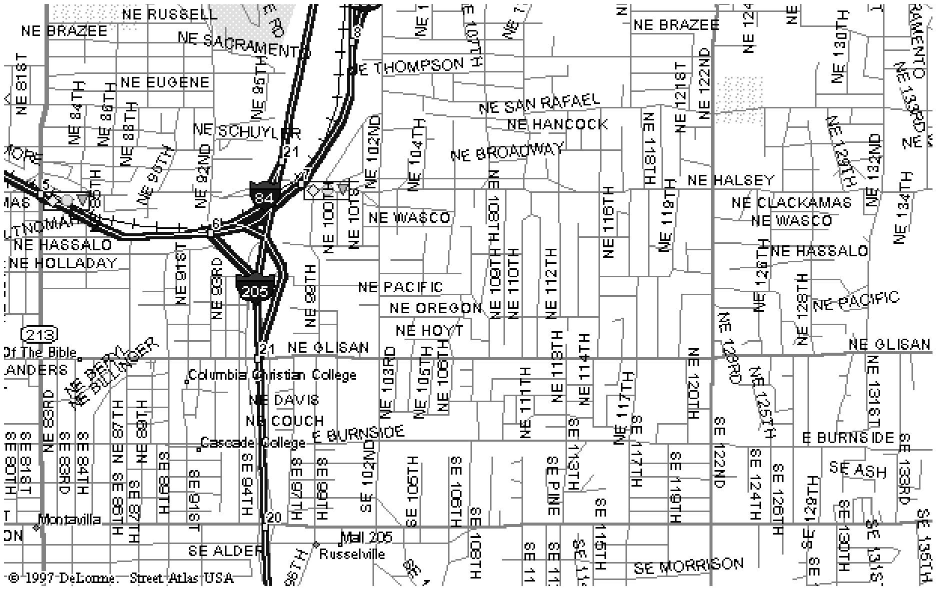


Figure A 6.9 Map of the Residential District

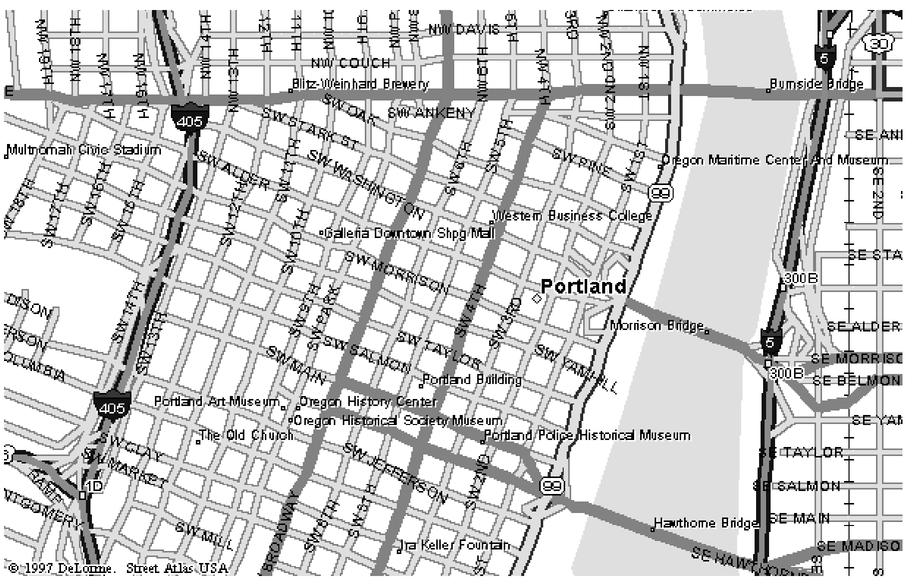
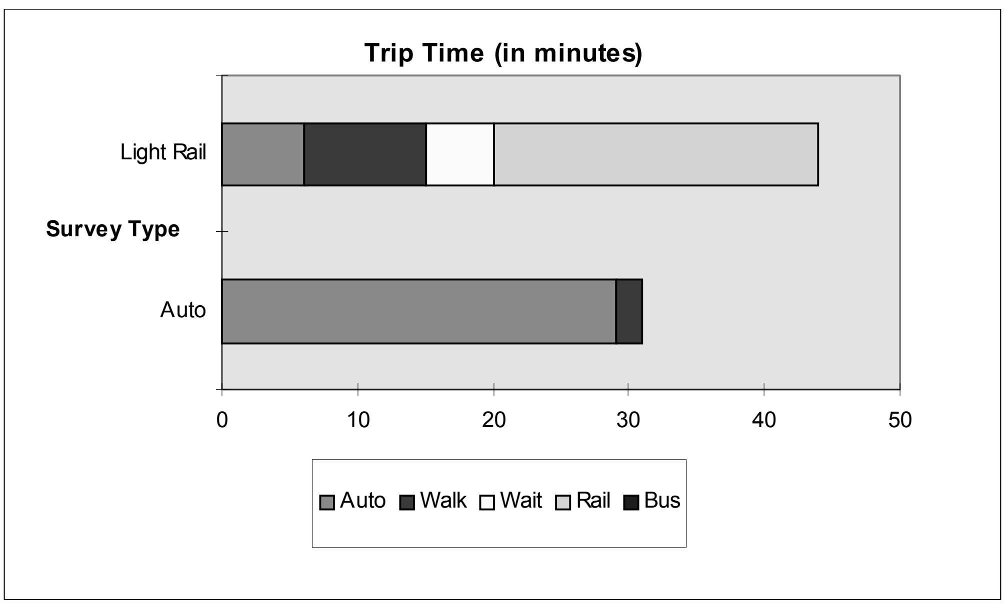


Figure A 6.10 Map of the Central Business District

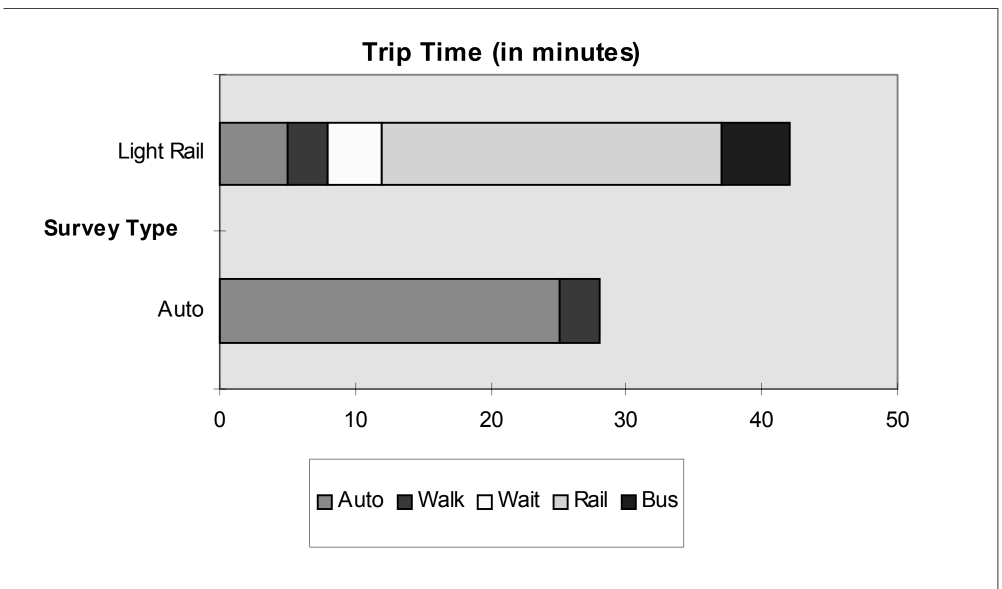
Annex A 6.2 The Survey Findings by Route

CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 1-B: NE Thompson & 108th Avenue - SW 4th & Madison		
	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	31	44
In Common Segment	19	24
Outside Common Segment	12	20
Wait Time	0	5
Walk Time	2	9
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	17.8	12.0
In Common Segment	23.4	17.6
Outside Common Segment	9.0	5.3



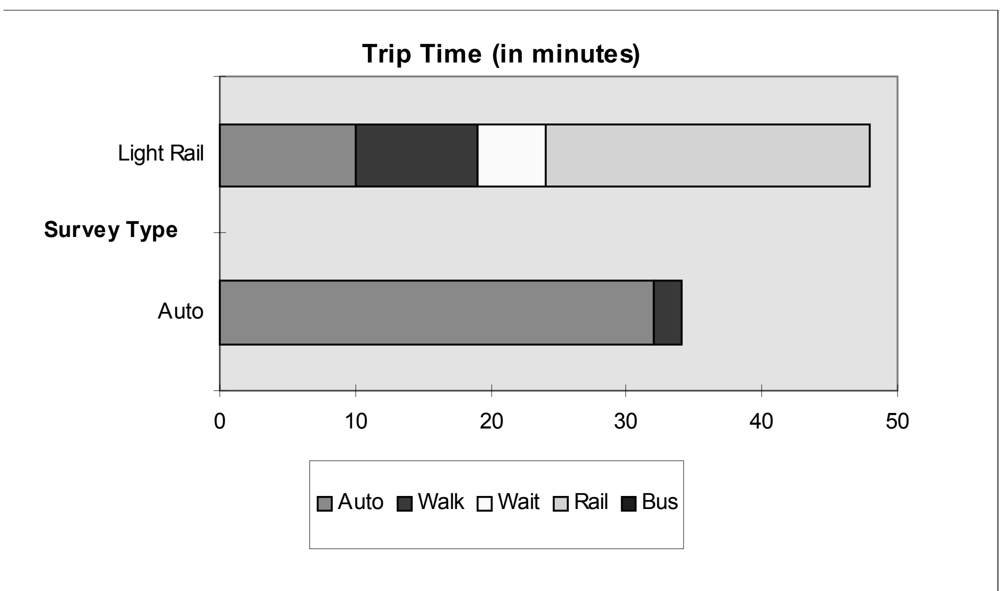
CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE 2-C:
NE Hancock & 111th Avenue - SW 5th & Main

	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	28	37
In Common Segment	19	25
Outside Common Segment	9	12
Wait Time	0	4
Walk Time	3	3
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	19.7	14.3
In Common Segment	23.4	16.9
Outside Common Segment	12.0	8.8

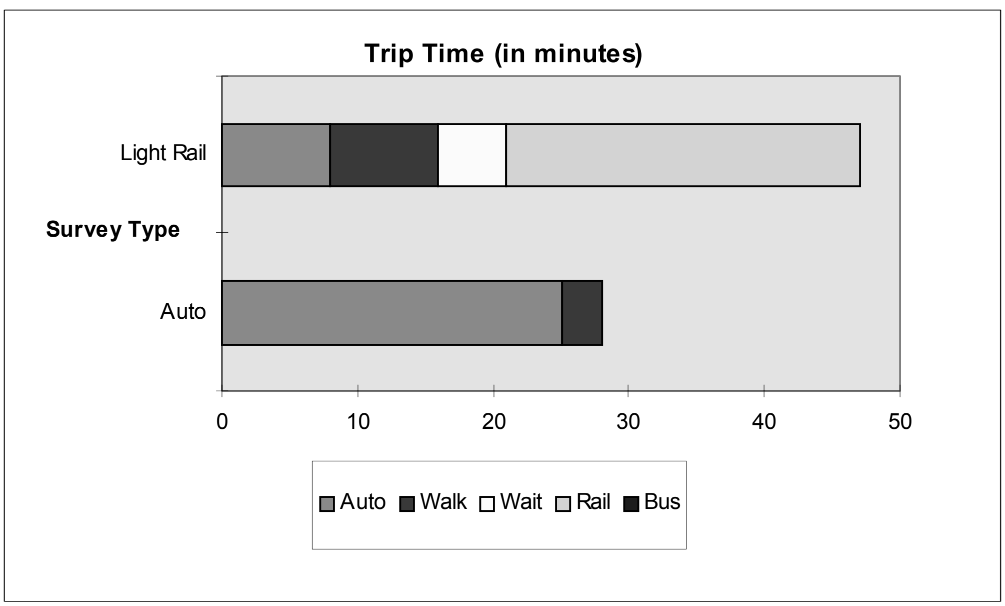


CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE 6-G:
NE Glisan & 113th Avenue - SW Park & SW Alder

	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	34	48
In Common Segment	24	24
Outside Common Segment	10	24
Wait Time	0	5
Walk Time	2	9
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	16.2	11.0
In Common Segment	18.5	17.6
Outside Common Segment	10.8	4.4

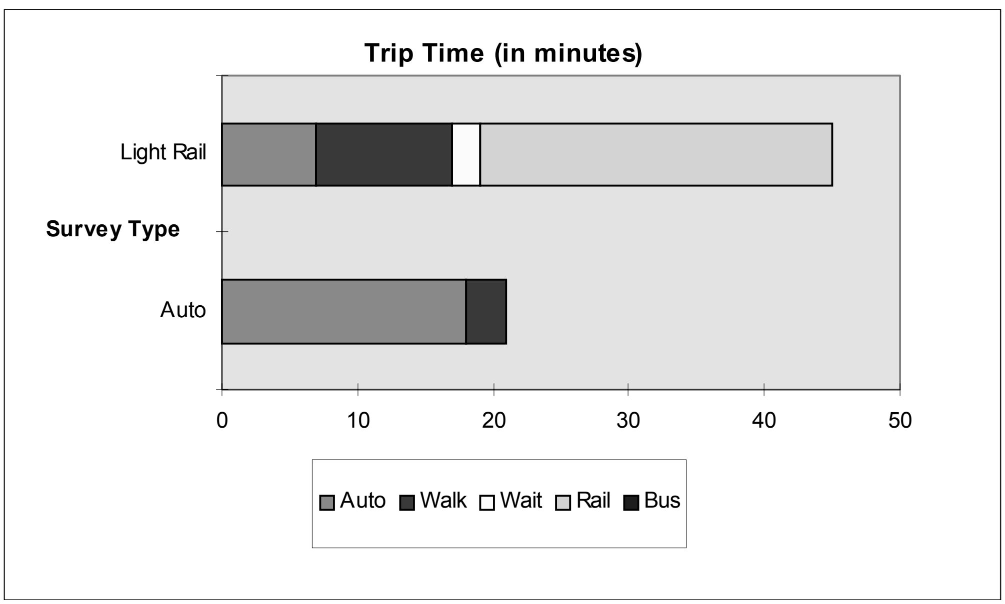


CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 8-I: NE Burnside & 109th Avenue - SW Washington & 5th Avenue	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	28	47
In Common Segment	20	26
Outside Common Segment	8	21
Wait Time	0	5
Walk Time	3	8
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	19.7	11.2
In Common Segment	22.2	16.2
Outside Common Segment	13.5	5.0



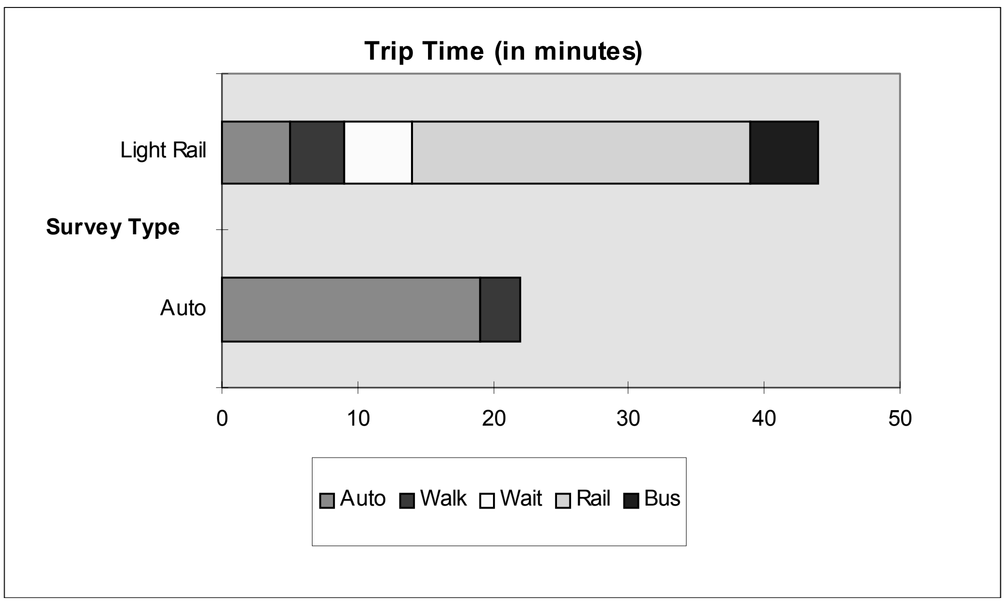
CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE B-2:
SW 4th & Madison Avenue - NE Hancock & 111th Avenue

	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	21	45
In Common Segment	10	26
Outside Common Segment	11	19
Wait Time	0	2
Walk Time	3	10
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	26.3	11.7
In Common Segment	44.4	16.2
Outside Common Segment	9.8	5.6

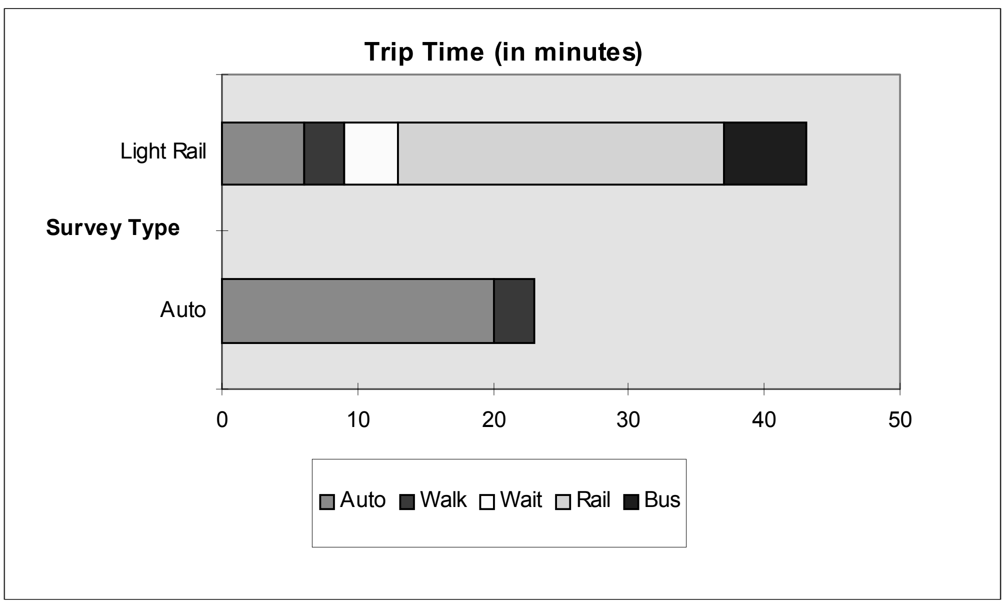


CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE C- 3:
SW 5th & Main - NE Halsey & 114th Avenue

	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	22	39
In Common Segment	9	25
Outside Common Segment	13	14
Wait Time	0	5
Walk Time	3	4
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	25.1	13.5
In Common Segment	49.3	16.9
Outside Common Segment	8.3	7.5

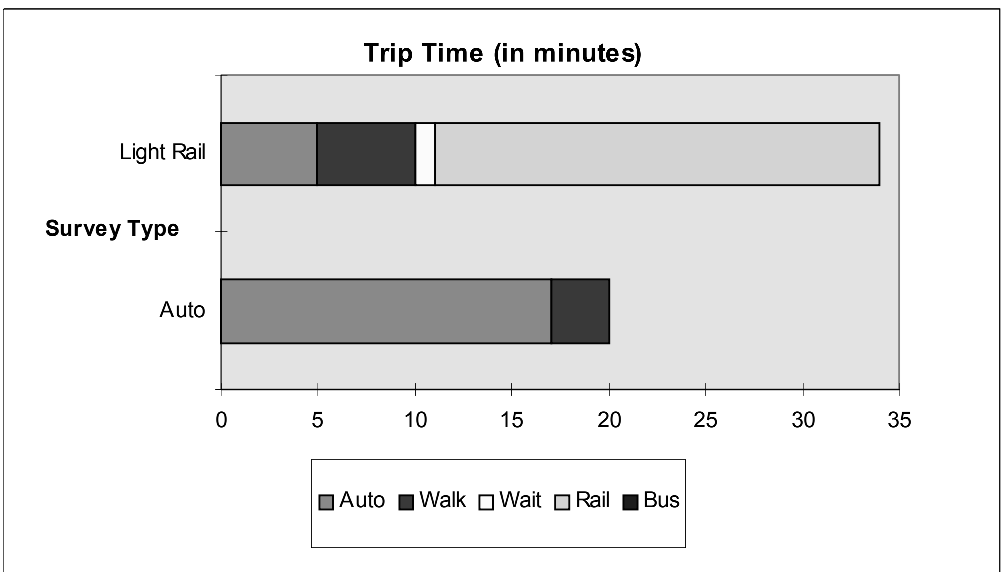


CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE D- 4: SW 6th & Salmon - NE Pacific & 117th Avenue	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	23	37
In Common Segment	9	24
Outside Common Segment	14	13
Wait Time	0	4
Walk Time	3	3
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	24.0	14.3
In Common Segment	49.3	17.6
Outside Common Segment	7.7	8.1

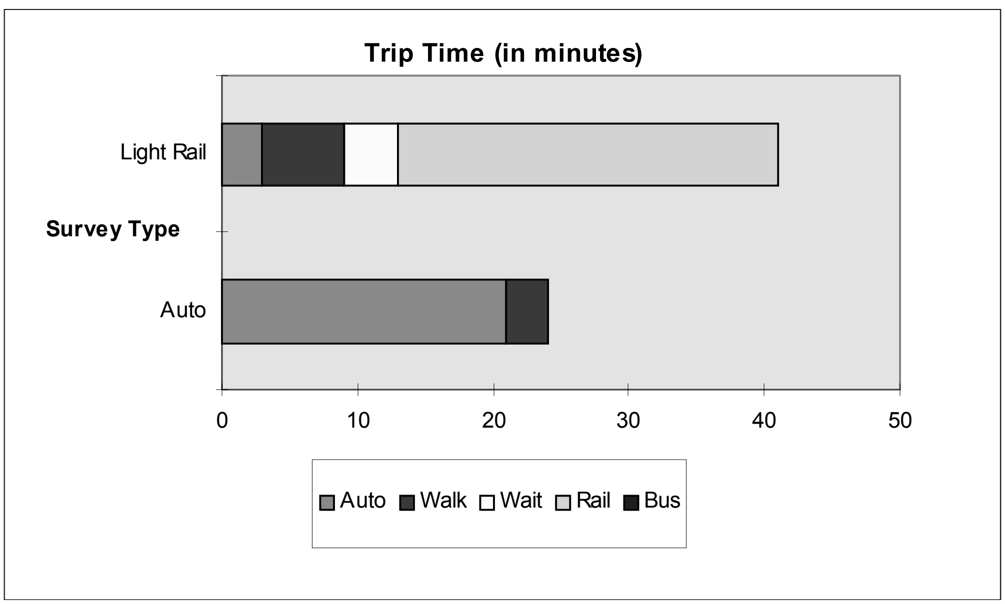


CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE G- 7:
SW Park & Alder - NE Glisan & 106th Avenue

	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	20	34
In Common Segment	10	23
Outside Common Segment	10	11
Wait Time	0	1
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	27.6	15.5
In Common Segment	44.4	18.4
Outside Common Segment	10.8	9.6

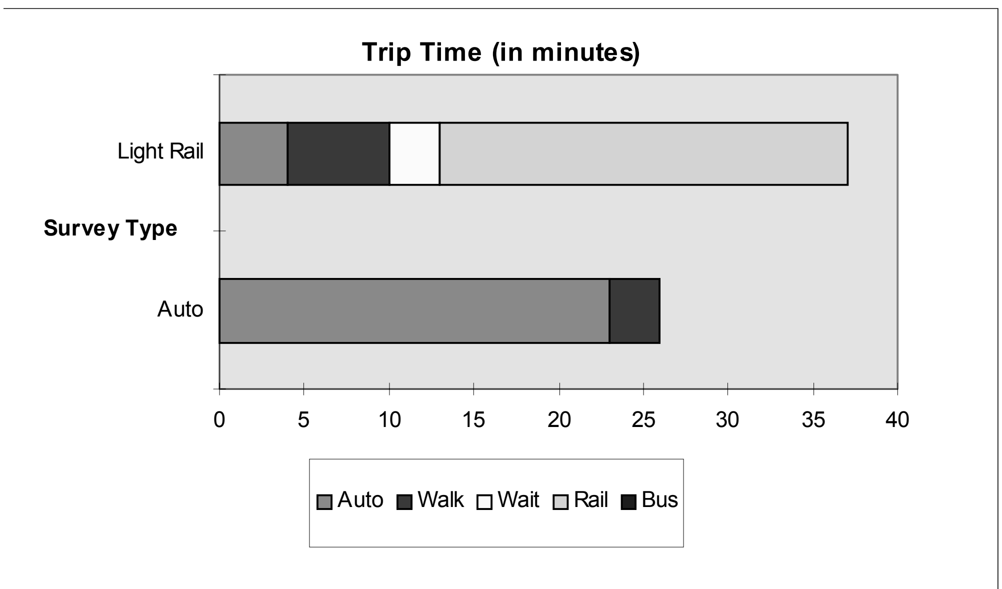


CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE I- 9: SW Washington & 5th Avenue - SE Burnside & 102nd Avenue		
	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	24	41
In Common Segment	11	28
Outside Common Segment	13	13
Wait Time	0	4
Walk Time	3	6
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	23.0	12.9
In Common Segment	40.4	15.1
Outside Common Segment	8.3	8.1

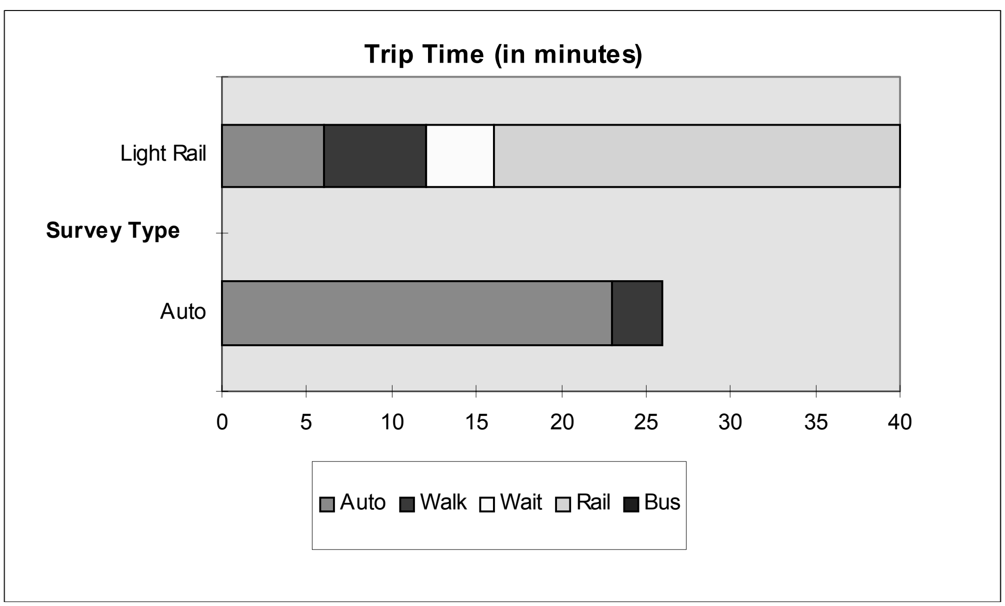


CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE 4- E:
NE Pacific & 117th Avenue - SW Broadway & Taylor

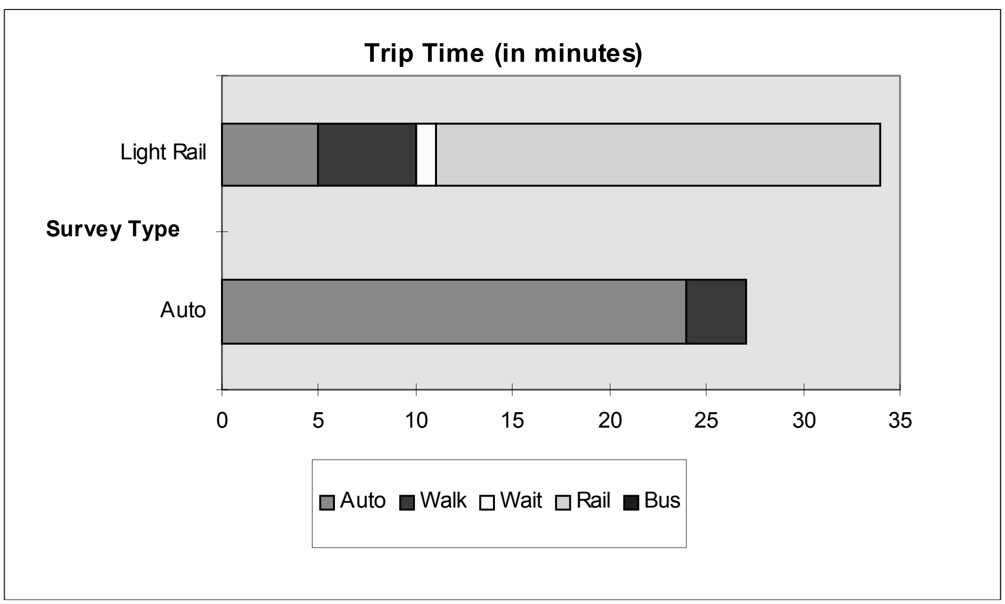
	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	26	37
In Common Segment	16	24
Outside Common Segment	10	13
Wait Time	0	3
Walk Time	3	6
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	21.2	14.3
In Common Segment	27.8	17.6
Outside Common Segment	10.8	8.1



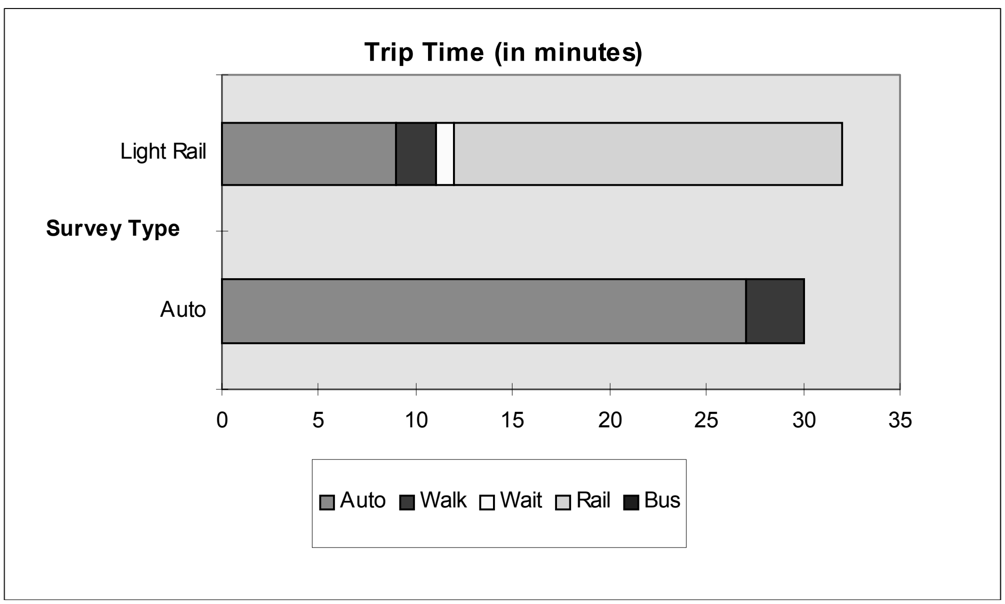
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 5- F: NE Oregon & 114th Avenue - SW Park & Yamhill	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	26	40
In Common Segment	13	24
Outside Common Segment	13	16
Wait Time	0	4
Walk Time	3	6
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	21.2	13.2
In Common Segment	34.2	17.6
Outside Common Segment	8.3	6.6



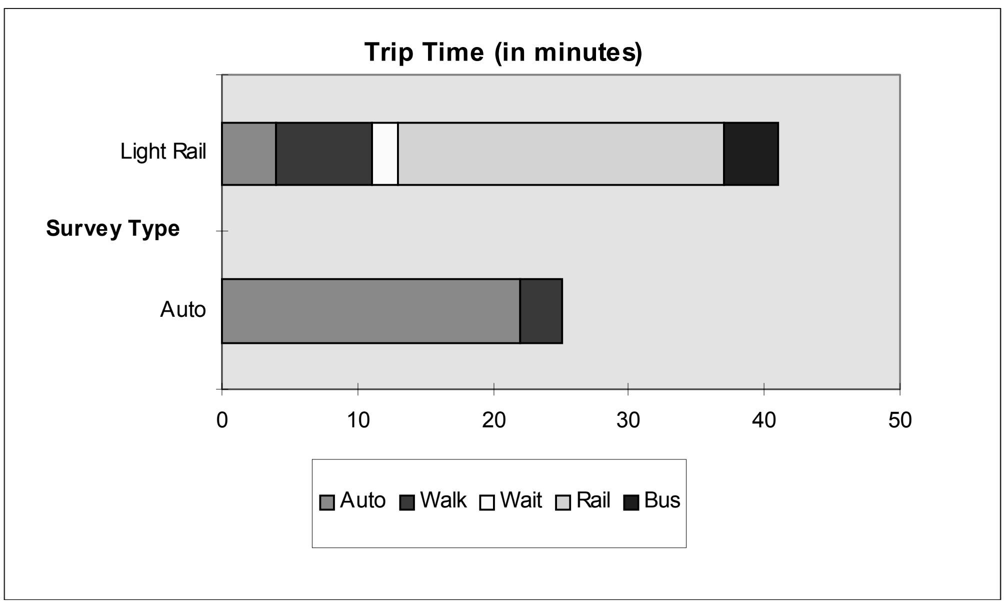
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 7- H: NE Glisan & 106th Avenue - SW Washington & 6th Avenue	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	27	34
In Common Segment	20	23
Outside Common Segment	7	11
Wait Time	0	1
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	20.4	15.5
In Common Segment	22.2	18.4
Outside Common Segment	15.4	9.6



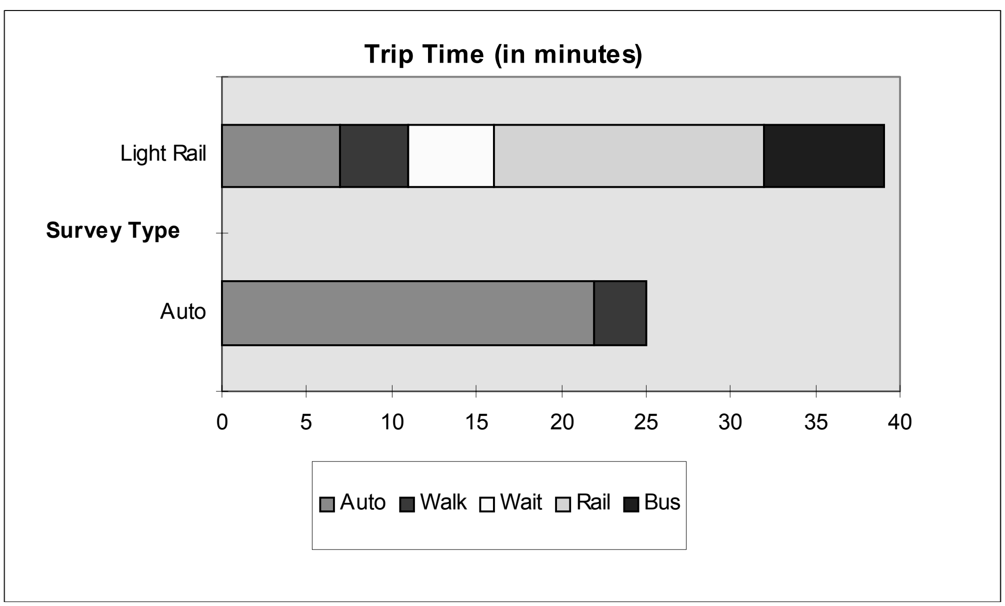
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 9- J: SE Burnside & 102nd Avenue - SW Stark & 6th Avenue		
	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	30	32
In Common Segment	22	20
Outside Common Segment	8	12
Wait Time	0	1
Walk Time	3	2
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	18.4	16.5
In Common Segment	20.2	21.1
Outside Common Segment	13.5	8.8



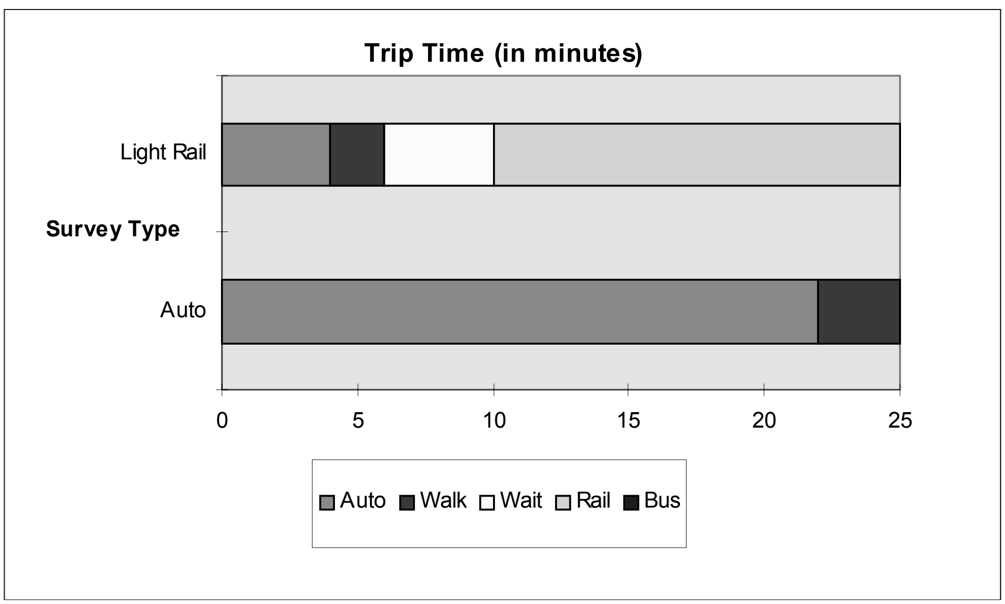
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 10- A: SE Stark & 99th Avenue - SW 3rd Avenue & Main	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	25	37
In Common Segment	15	24
Outside Common Segment	10	13
Wait Time	0	7
Walk Time	3	2
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	22.1	14.3
In Common Segment	29.6	17.6
Outside Common Segment	10.8	8.1



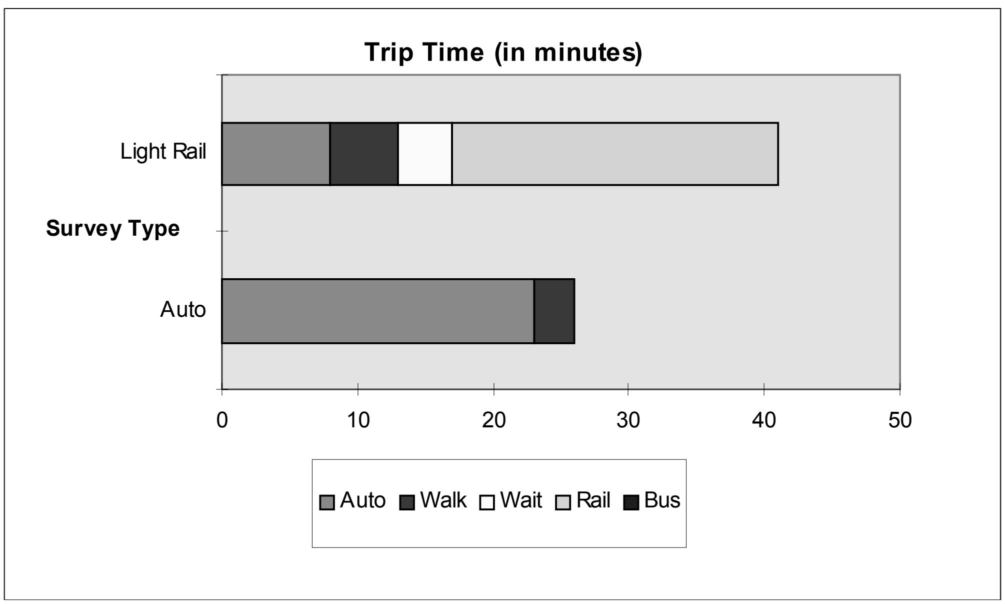
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE E- 5: SW Broadway & Taylor Avenue - NE Oregon & 114th Avenue	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	25	32
In Common Segment	13	16
Outside Common Segment	12	16
Wait Time	0	5
Walk Time	3	4
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	22.1	16.5
In Common Segment	34.2	26.4
Outside Common Segment	9.0	6.6



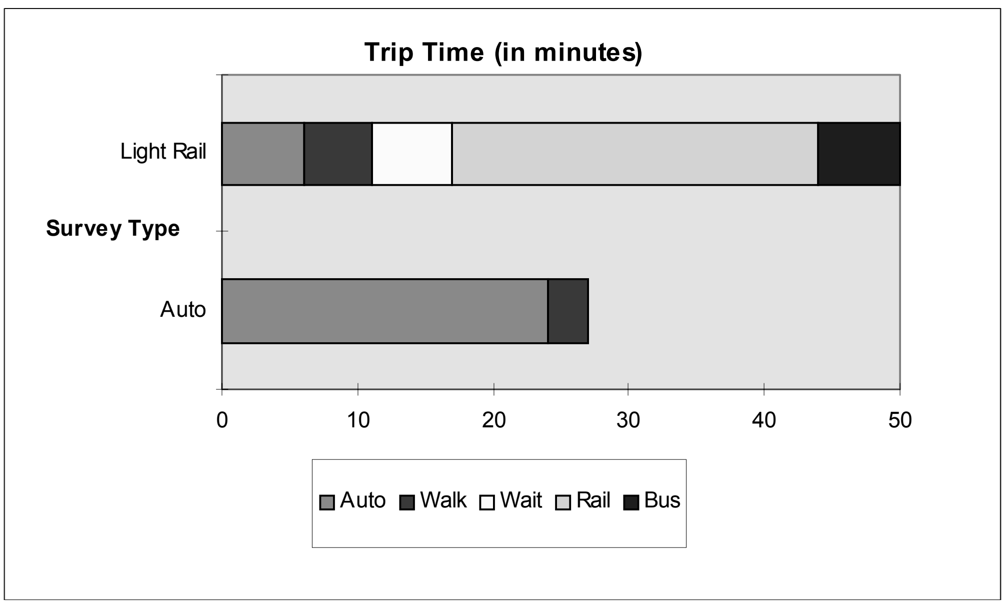
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE F- 6: SW Park & Yamhill Avenue - NE Glisan & 113th Avenue	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	25	25
In Common Segment	12	15
Outside Common Segment	13	10
Wait Time	0	4
Walk Time	3	2
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	22.1	21.1
In Common Segment	37.0	28.2
Outside Common Segment	8.3	10.6



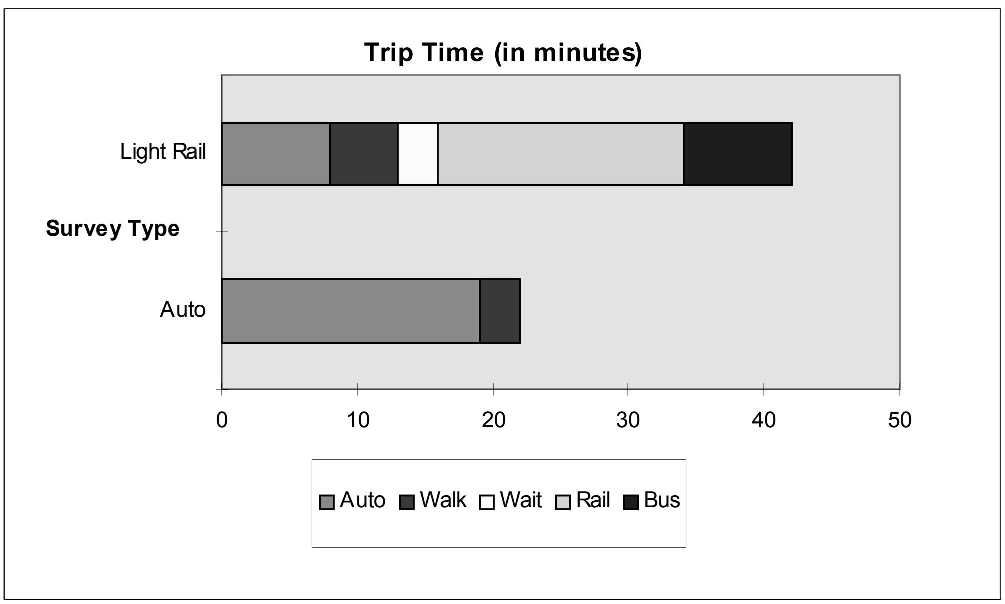
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE H- 8: SW Washington & 6th Avenue - NE Burnside & 109th Avenue		
	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	26	41
In Common Segment	12	24
Outside Common Segment	14	17
Wait Time	0	4
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	21.2	12.9
In Common Segment	37.0	17.6
Outside Common Segment	7.7	6.2



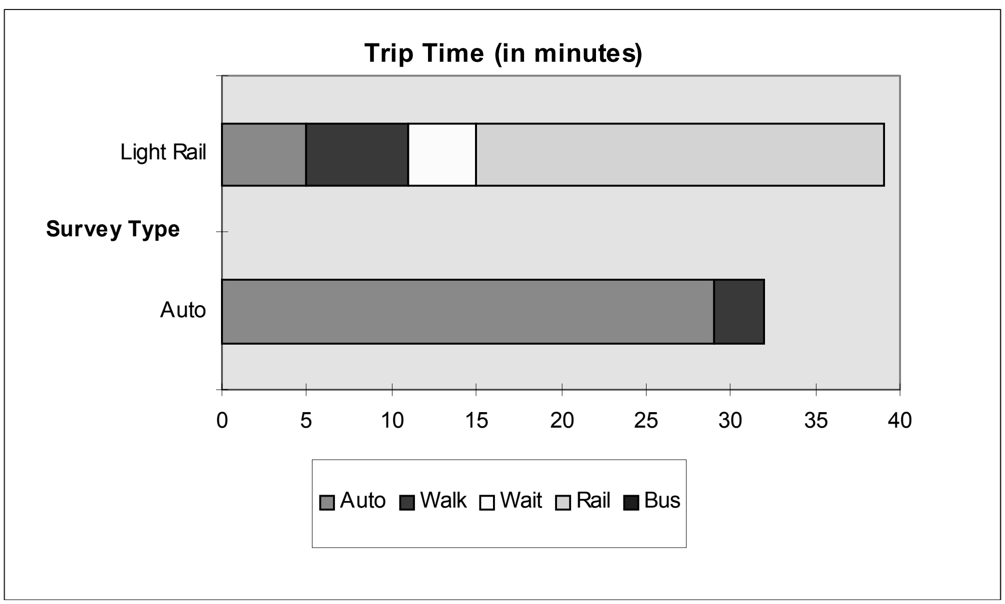
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE J- 10: SW 4th Avenue and Stark - SE Stark & 99th Avenue	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	27	44
In Common Segment	15	27
Outside Common Segment	12	17
Wait Time	0	6
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	20.4	12.0
In Common Segment	29.6	15.6
Outside Common Segment	9.0	6.2



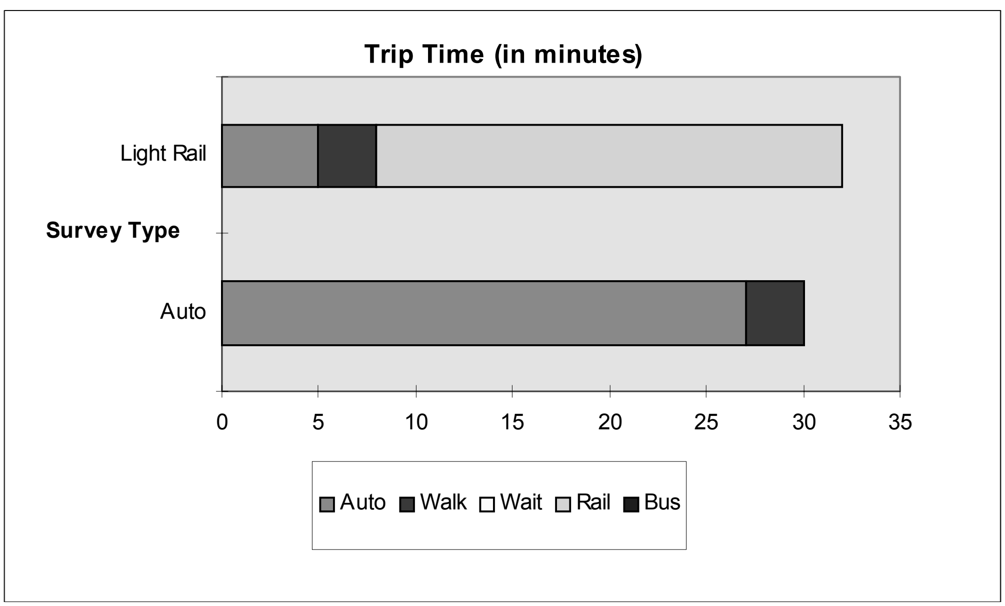
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE A- 1: SW 3rd Avenue and Main - NE Thompson & 108th Avenue		
	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	22	34
In Common Segment	12	18
Outside Common Segment	10	16
Wait Time	0	3
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	25.1	15.5
In Common Segment	37.0	23.5
Outside Common Segment	10.8	6.6



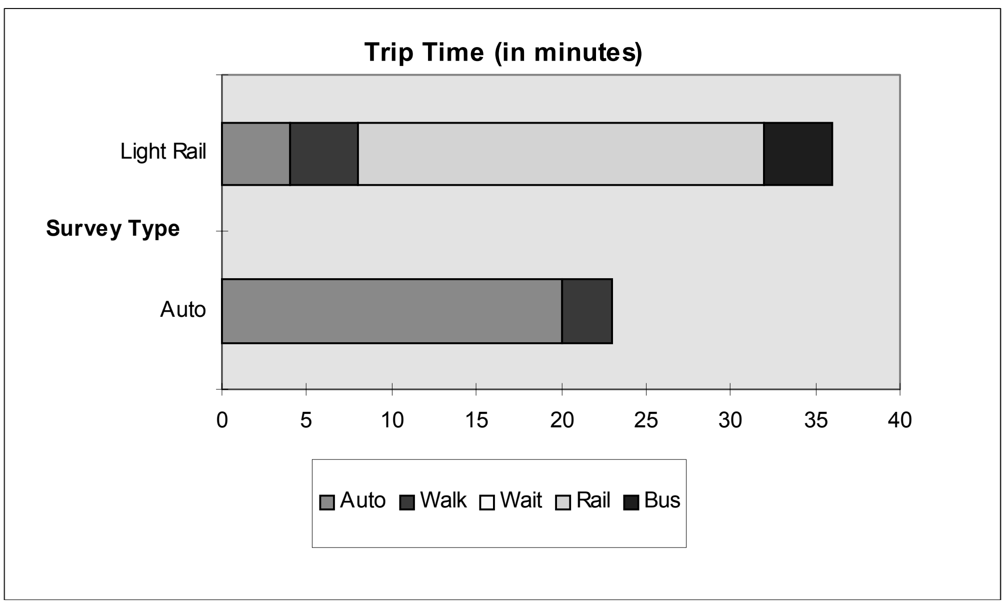
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 8- B: NE Burnside & 109th Avenue - SW 4th Avenue & Madison	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	32	39
In Common Segment	19	24
Outside Common Segment	13	15
Wait Time	0	4
Walk Time	3	6
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	17.3	13.5
In Common Segment	23.4	17.6
Outside Common Segment	8.3	7.0



CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 9- C: SE Burnside & 102nd Avenue - SW 5th Avenue & Main	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	30	32
In Common Segment	16	24
Outside Common Segment	14	8
Wait Time	0	0
Walk Time	3	3
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	18.4	16.5
In Common Segment	27.8	17.6
Outside Common Segment	7.7	13.2

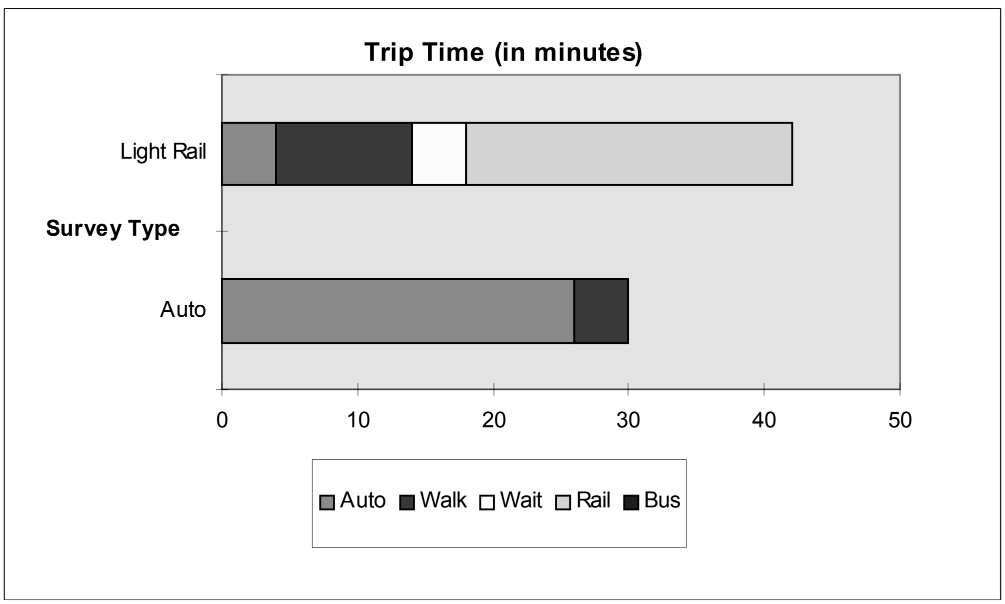


CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 10- D: SE Stark & 99th Avenue - SW 6th Avenue & Salmon	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	23	32
In Common Segment	14	24
Outside Common Segment	9	8
Wait Time	0	0
Walk Time	3	4
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	24.0	16.5
In Common Segment	31.7	17.6
Outside Common Segment	12.0	13.2

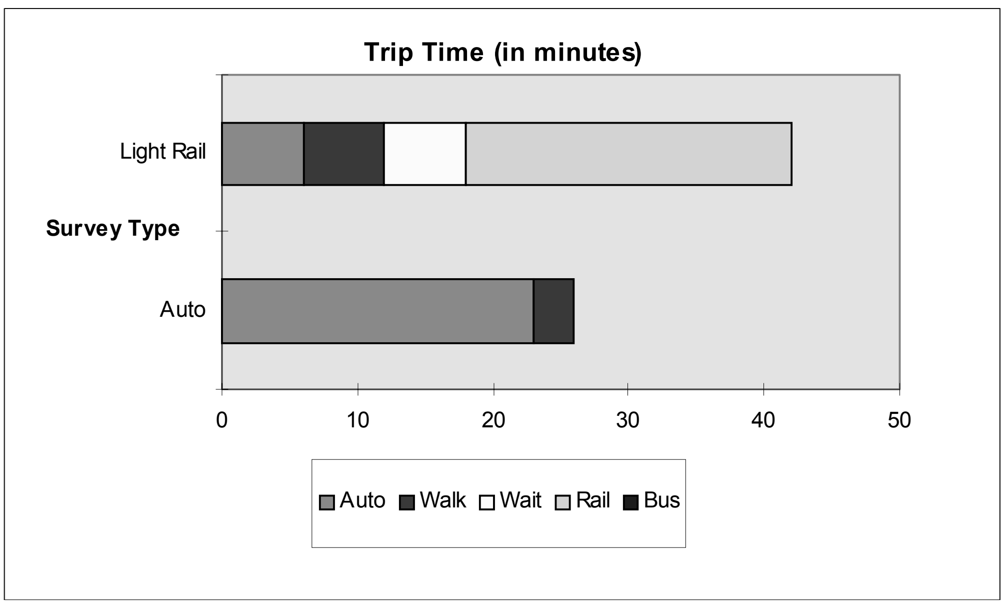


CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE 2- I:
NE Hancock & 111th Avenue - SW Washington & 5th Avenue

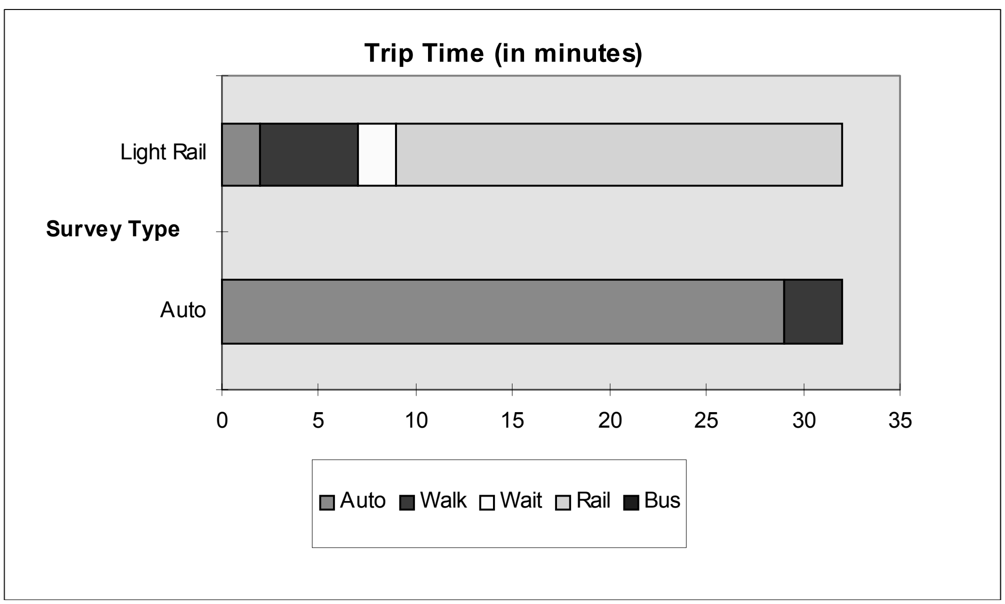
	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	30	42
In Common Segment	17	24
Outside Common Segment	13	18
Wait Time	0	4
Walk Time	4	10
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	18.4	12.6
In Common Segment	26.1	17.6
Outside Common Segment	8.3	5.9



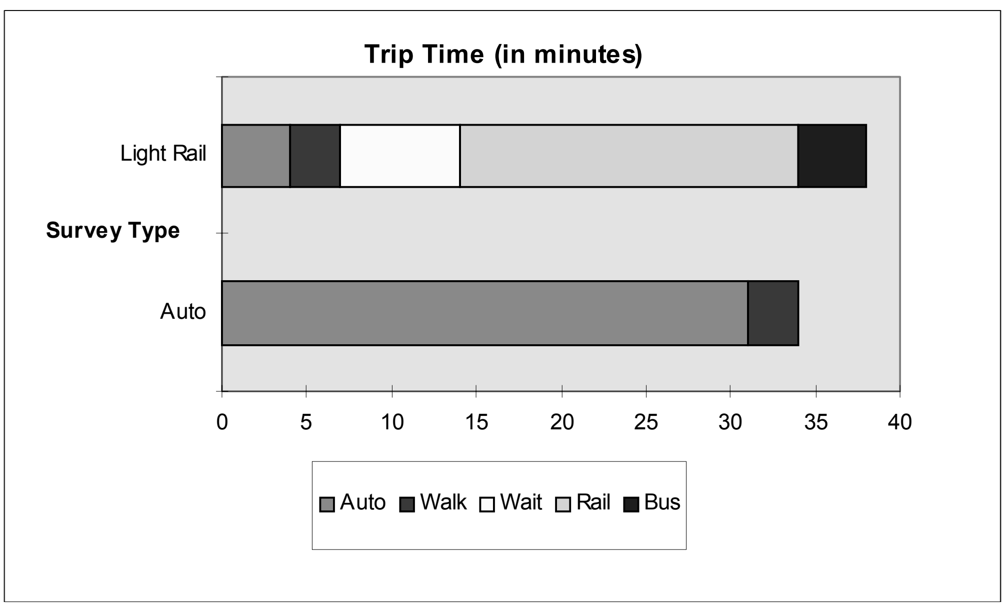
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE 1- H: NE Thompson & 108th Avenue - SW Washington & 6th Avenue		
	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	26	42
In Common Segment	15	24
Outside Common Segment	11	18
Wait Time	0	6
Walk Time	3	6
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	21.2	12.6
In Common Segment	29.6	17.6
Outside Common Segment	9.8	5.9



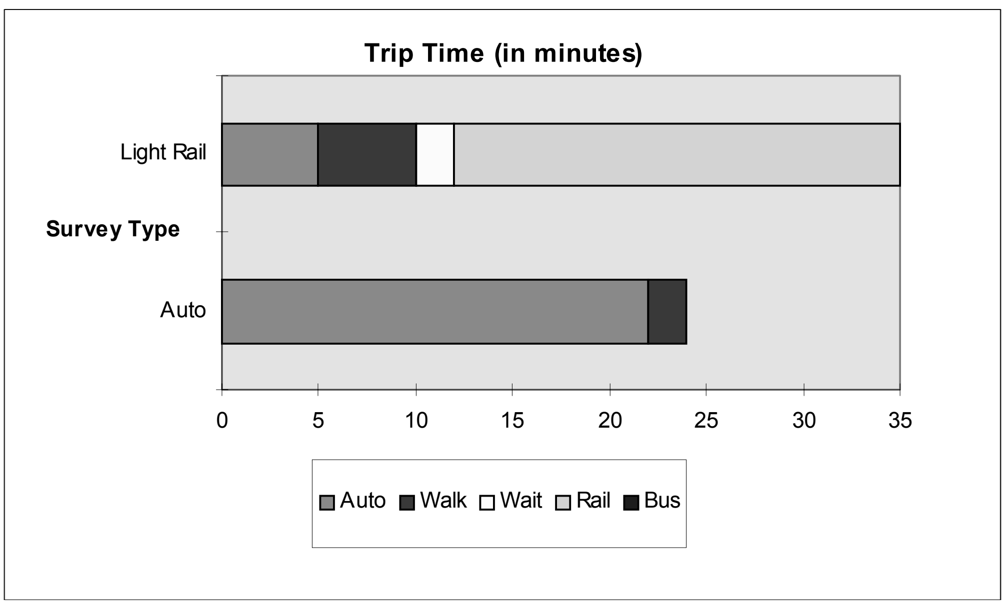
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE B- 9: SW 4th & Madison Avenue - SE Burnside & 102th Avenue	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	32	32
In Common Segment	17	23
Outside Common Segment	15	9
Wait Time	0	2
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	17.3	16.5
In Common Segment	26.1	18.4
Outside Common Segment	7.2	11.7



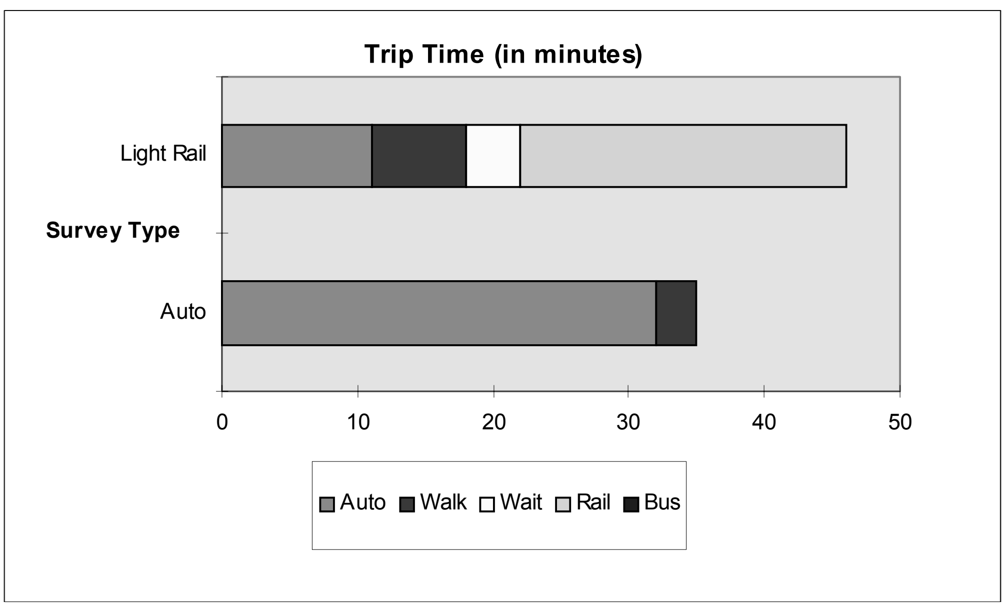
CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE C- 10: SW 5th Avenue & Main - SE Stark & 99th Avenue	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	34	34
In Common Segment	22	20
Outside Common Segment	12	14
Wait Time	0	7
Walk Time	3	3
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	16.2	15.5
In Common Segment	20.2	21.1
Outside Common Segment	9.0	7.5



CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE I- 2: SW Washington & 5th Avenue - NE Hancock & 111th Avenue	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	24	35
In Common Segment	12	23
Outside Common Segment	12	12
Wait Time	0	2
Walk Time	2	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	23.0	15.1
In Common Segment	37.0	18.4
Outside Common Segment	9.0	8.8



CORRIDOR: GATEWAY - PORTLAND SUMMARY TABLE FOR ROUTE A- 8: SW 3rd Avenue & Main - NE Burnside & 109th Avenue	SURVEY TYPE	
TIME (minutes)	Auto	Light Rail
Trip	35	46
In Common Segment	21	24
Outside Common Segment	14	22
Wait Time	0	4
Walk Time	3	7
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	15.8	11.5
In Common Segment	21.1	17.6
Outside Common Segment	7.7	4.8



CORRIDOR: GATEWAY - PORTLAND
SUMMARY TABLE FOR
ROUTE J- 1:
SW 4th Avenue & Stark - NE Thompson & 108th Avenue

	SURVEY TYPE	
	Auto	Light Rail
TIME (minutes)		
Trip	34	46
In Common Segment	25	25
Outside Common Segment	9	21
Wait Time	0	8
Walk Time	3	5
DISTANCE (miles)		
Route Distance	9.2	8.8
Common Segment Distance	7.4	7.0
SPEED (mph)		
Trip	16.2	11.5
In Common Segment	17.8	16.9
Outside Common Segment	12.0	5.0